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# Information technology in supply chain management: a case study

Ming-Lang Tseng[a], Kuo-Jui Wu[b] and Thi Thoa Nguyen[a]

[a]*Graduate School of Business and Management[c], Lunghwa University of Science and Technology, Taiwan*
[b]*Department of Buisness,MBA, De La Salle University, Manila, Philippines*

*No. 300, Sec. 1, Wanshou Rd., Guishan, Taoyuan, Taiwan, 33306,*

**Abstract**

This study attempts to prove the impact of information technology (IT) in supply chain management (SCM). The criteria include the applications of IT to get the high firm performance comprising marketing performance, financial performance, and customer satisfaction. The fuzzy DEMATEL method is applied to show out the interrelationships among all of criteria. The result finds that advanced IT is the cause criteria leading to marketing performance and customer satisfaction. The implications give some considered elements to the Vietnam textile industry when apply IT. The limitations and directions for future research are included in the final section.

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*Keyword:* green supply chain management, fuzzy set theory, Decision Making Trial and Evaluation Laboratory (DEMATEL)

## 1. Introduction

The textile industry in Vietnam is considered the most essential industry in export. The government is planning to improve competitive capability so that contribute more to national's GDP. In reality, most of the textile enterprises are equipped with computers in public administration, business operations, using the Internet to access information and relationships with clients. There are no enterprises are equipped with software for partner relationship management, resources management and advanced production system. It has adverse effects on achieving the competitive priority of apparel products on environment


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dynamics. Slowly response to market changes, high production costs make the garment industry gradually lost competitiveness. The solution to this difficult problem is information technology (Vietnamese Economic Forum, 2011).

In the business environment, information technology (IT) plays an important role for firms' performance. It provides information flow which makes the supply chain more robust and resilient without undermining its efficiency. In previous years, most companies are increasingly applying IT systems in practice in supply chain management (SCM) to improve their performance in global competitive markets (Bayraktar et al., 2009). Recent progresses in both information and technology and scientific management have enabled many industries practices of acquiring, sharing, and using information (Fu et al., 2010). There has been an increasing literature that either quantifies the value of information in SCM (Cachon and Fisher, 2000; Donohue, 2000; Lee et al., 2000; Moinzadeh, 2002) or studies the incentives of information sharing (Corbett and de Groote, 2000; Cachon and Lariviere, 2001; Ha, 2001; Özer and Wei, 2006). IT integration supports a better supply chain integration and flexibility (Eric et al, 2010). So, this study attempts to show out the kinds of firm performance be affected by IT in SCM.

In literatures, the collaborative investment in IT among supply chain stakeholders has become a strategic thrust to achieve more transparent and supply chains (Corsten and Kumar, 2005; Zhou, 2009). With the increasing use of an integrated information systems and enabling technologies, it has become possible now to create seamless supply chains linking suppliers to customers in order to eliminate poor performance of the suppliers, unpredictable customer demands, and uncertain business environment (Bayraktar et al., 2009). Nevertheless, the investment required among supply chain stakeholders to adopt new IT often does not occur as a desired, even though such collaborative efforts can create unique value that a single firm cannot attain independently (Dutta et al 2007).

There are plenty of researches about the role of SCM in companies, but the investment of IT in SCM and to what extend it providing benefit in textile company in Vietnam seem to be empty. The objective of current study is to analysis the degree to which IT in SCM will improve firm's value. Aforementioned, the garment companies are facing challenges in global markets. The finding will gives some implications in management as well in practice. The remainder of the study, literature review will be presented in the section two, methodology applying DEMATEL to come up with result in section three and four, some implications in the section five and concluding remark in the final section.

## 2. Green supply chain management

This section comprises finding criteria which gives sharp evidences for current discussion. Proposed method shows out the wise way to apply DEMATEL to solve the interrelationship among all criteria.

*2.1 Information technology in supply chain management*

More recent evidence has demonstrated that companies obtain large benefits from IT application. Uncovered significant productivity gains from flow of information (Barua and Lee 1997). Other studied have argued persuasively that enough evidence has been gathered on the positive effects of IT that the productivity paradox can be labeled a myth of the past (Mukhopadhyay et al., 1997). There seems to be a truth that information system investment does pay off now, determining how it does remains a mystery. Previous studies noted that IT value research had ignored the synergistic effects of IT with other organizational factors such as business strategies, mass customization, and supply chain management. Information software does not operate in a vacuum; it works very closely with other firm assets (Andersen et al., 2001). However, (Brooks and Davenport, 2004; Lou et al., 2004) argued that technologies are characterized by high levels of uncertainty due to its vital characteristics of: autonomy (Jennings and Wooldridge, 1995), social ability (Moyaux and Chaib-draa, 2006), reactivity (Parunak, 1999), and pre-activeness (Moyaux and Chaib-draa, 2006). It was assumed that the diffusion of IT into the activities of the SC amplified its value-creating potential. IT has potential to manage the flow and to impact many of the dimensions of the SC such as cost, quality, delivery, flexibility, and ultimately the profits of the firm (Brandyberry at el., 1999).

Sanders et al. (2002) presented the direct relationship between technology use in SCM was reported that organizations use IT more than the norm in their industry, achieve more operational benefits; such as reduced cost and cycle time. However, the effective between IT use and supplier network performance is moderated by industry clock-speed (Guimaraes et al., 2002). Narasimhan and Kim (2001) supported certain types of IT systems are more relevant for SCM that help firms improve production and process control, price management, customer service, customer management, inventory, and warehouse management. Material requirements planning (MRP) (C1) is production planning used to coordinate order fulfillment by synchronizing material and resources availability to customer demand (Koh, 2004). Effective use of the system could result in better resource planning and reduce inventory level, through releasing purchase and/or work orders only when they are needed. Technologies in enterprise resource planning (ERP) (C2) have been designed to address the fragmentation of information across an enterprise's business, to integrate with intra- and inter- enterprise information (Sharif et al., 2005). Nevertheless, it is debated that the efficacy of conventional ERP systems to provide real time synchronization among supply chain partners which is necessary for effective SCM is limited (Karwowski et al., 2007). Advanced planning system (APS) (C3) predicts potential future effects on the plan as a result of historical uncertainty pattern and potential future uncertainty. With effectively use, this IS practice will result in better forecasting and improved resource planning leading to better operational efficiency (Lockhamy III and McCormack, 2004).

Chae et al., (2005) proved that the existing relationships between the channel partners were moderated by the ability of IT to influence inter-organizational collaboration. The information sharing capability positively influences firm performance with higher levels of both connectivity and willingness to share information (Fawcett et al., 2008). Therefore, the

implementing IT for promoting connectivity among SC partners requires a commitment to exchange information to realize better performance. A well integrated IT system can provides a clear picture of supply chain status, inventory status (of the manufacturers or its suppliers), and even the service capability of its logistic providers. IT allows suppliers to be able to access the inventory information of their customers and prepare for stock delivery on time (Ngai et al., 2010). However, it is argued that the uncertain impact of IT on different aspects of SCM and disappointing outcomes of IT investment posing a serious challenge to the vital role of IT in a company's performance is possible (Ye and Farley, 2006; Kim et al., 2006). With the support of IT, organization can keep to tract of market needs and to relocate resources in a responsive manner (Ngai et al., 2010). So, the supplier relationship management system (SRM) (C4) and customer relationship management systems (CRM) (C5) are integrated in this study (Bayraktar et al., 2009).

The IT in SC can impact firm performance in several ways. First, an integrated system helps to achieve benefits through allowing a firm to respond better to customer problem and requests (Rogers et al., 1993). Second, information flows facilitated by the IT can potentially increase the sales volume by reaching customers directly and promptly whenever a new product is introduced, and by tapping into markets that were inaccessible on account of distribution or other infrastructure constraints (Wu, Mahajan, and Balasubramanian, 2003). The impact of IT on supply chain is a measure of the influence of IT applications across many activities, the interactions of organizations and some with external entities such as customers and suppliers (Byrd et al., 2003). The present study conducts three firm performances including marketing performance (C6), financial performance (C7) and customer satisfaction (C8). Marketing performance includes sales growth, market share, product development, and market development. Financial performance includes profitability, ROI, and cash flow from operations (Wu et al., 2006; Tseng 2011a;b). Customer satisfaction mentions fulfill various customer demand (Kim, 2009).

Nevertheless, these IS practices for managing firm's operations are not enough (Koh et al 2006). Due to its system rigidity and incapability to deal with uncertainty (Koh and Saad, 2002), other systems of technologies such as radio frequency identification (RFID), mobile and wireless technologies, would help to achieve the success order, part and product traceability and operational efficiency (Koh and Gunasekaran, 2006; Sevkli et al., 2007). The applications of technologies such as RFID, global positioning system (GPS), wireless and mobile (C9) have been included in manufacturing (Lu et al., 2006), services (Wu et al., 2005), logistics and distributions (Giaglis et al., 2004), healthcare (Tzeng et al., 2008) and retailing (Prater et al., 2005). These technologies are normally used along with IS systems to allow ubiquitous flow of information in supply chain (Ngai et al., 2008). Hence, these technologies can be considered as a category of the IS practice. Electronic data interchange (EDI) (C10) allows suppliers to ascertain when to replenish the parts/products, thus reducing inventory level and improving forecasting (Bayraktar et al., 2009).

IT can contribute a very important role in SCM. Many of research have examined the relationship between SCM and IT range from surveys, to case studies, and simulations (Chatfield et al, 2000; Guimaraes et al, 2002; Ranganathan et al, 2004). The previous research model have conducted the directly links between IT use in the supply chain and

performance gains, while others have modeled the presence of mediators and moderators as qualifies of the relationship between two constructs (Chae et al, 2005; Premkumar et al, 2005; Rai et al, 2006; Tseng et al., 2011; Chen et al., 2011; Lin et al., 2011). This study considers IT investment in supply chain as causes and higher firm performance as effects via applying DEMATEL.

Table 1. The proposed criteria

| Goal | Criteria | Source |
|---|---|---|
| Information technology in supply chain management | Material requirements planning (MRP) (C1) | Koh, 2004 |
| | Enterprise resource planning (ERP) (C2) | Sharif et al., 2005 |
| | Advanced planning system (APS) (C3) | Lockhamy III and McCormack, 2004 |
| | Supplier relationship management (SRM) (C4) | Bayraktar et al., 2009 |
| | Customer relationship management (CRM) (C5) | |
| | Marketing performance (C6) | Wu et al., 2006 |
| | Financial performance (C7) | |
| | Customer satisfaction (C8) | Kim, 2009 |
| | RFID, GPS, wireless and mobile (C9) | Lu et al., 2006 |
| | Electronic data interchange (EDI) (C10) | Bayraktar et al., 2009 |

*2.2 Proposed method*

The DEMATEL method has been successfully applied in many fields (Hori and Shimizu 1999; Sankar and Prabhu 2001; Seyed-Hosseini et al. 2006; Liou and Tzeng 2007; Lin and Wu 2008). So far, there is no application of DEMATEL in IT in SCM. Recently, there are many studies in fuzzy DEMATEL applications in different fields. Wu (2008) studied on the KM strategy selection with considering a large number of complex factors as multiple evaluation criteria. The study proposes an effective solution based on a combined ANP and DEMATEL approach to help companies that need to evaluate and select KM strategies. Wu and Lee (2007) arises an issue on how to enrich global managers' competencies by way of segmenting a set of competencies into some portions in order to facilitate competency development with a stepwise mode. To solve this issue involving the vagueness of human judgments, they proposed an effective method combining fuzzy logic and DEMATEL to segment required competencies for better promoting the competency development of global managers. The studies of Tzeng et al. (2007) in e-learning were evaluated in numerous and intertwined facets and criteria; a multi-criteria decision-making model is suitable for e-learning evaluation. Using this e-learning effectiveness evaluation model, the evaluators find the aspects needing improvement, so that e-learning program effectiveness could increase. Empirical experimental results show the proposed model is capable of producing effective evaluation of e-learning program with adequate criteria that fit with respondent's perception patterns, especially when the evaluation criteria are numerous and intertwined. Using grey-fuzzy DEMATEL approach was applied in service

expectation (Tseng 2009). Fuzzy DEMATEL was developed to select suppliers in SCM (Chang et al, 2011). Since the fuzzy DEMATEL has been successfully evaluated in many fields, the IT in SCM needs to develop a full understanding of cause and effect relationships. The preliminary literature reviewed illustrates the criteria of IT in SCM lack the study on the relationships concerns and uncertainty for developing cause and effect relationship described in linguistic information. The following section presents the combined research method triangular numbers and defuzzification applied in this study and the fuzzy DEMATEL method.

## 3. Methodology

This section justified using linguistic information in complex evaluation systems. A complex evaluation environment can be divided into subsystems to more easily judge differences and measurement scores. The proposed hybrid method is used to construct a visual map for further strategic decision.

### *3.1. Fuzzy set theory*

Some important definition and notation of fuzzy set theory from Chen (1996) and Cheng and Lin (2002) were reviewed. The fuzzy aggregation method always needs to contain a defuzzification method because the results of human judgments with fuzzy linguistic variables are fuzzy numbers. The term defuzzification refers to the selection of a specific crisp element based on the output fuzzy set, which converts fuzzy numbers into crisp score. This study applies the converting fuzzy data into crisp scores (Opricovic and Tzeng, 2004), the main procedure of determining the left and right scores by fuzzy minimum and maximum; the total score is determined as a weighted average according to the membership functions.

Table 2. Linguistic scales for the importance weight of criteria

| Five-points scale | Linguistic variable | Triangular fuzzy numbers (TFN) |
|---|---|---|
| 1 | No influence | (0, 0.1, 0.3) |
| 2 | Very low influence | (0.1, 0.3, 0.5) |
| 3 | Low influence | (0.3, 0.5, 0.7) |
| 4 | High influence | (0.5, 0.7, 0.9) |
| 5 | Very high influence | (0.7, 0.9, 1.0) |

### *3.2 The DEMATEL method*

The DEMATEL method is especially practical and useful for visualizing the structure of complicated causal relationships with matrices or digraphs (Fontela & Gabus, 1976). The matrices or digraphs portray a contextual relation between the elements of the system, in which a numeral represents the strength of influence. Hence, the DEMATEL method can convert the relationship between the causes and effects of criteria into an intelligible structural model of the system. The essentials of the DEMATEL method suppose that a system contains a set of criteria C ={C1,C2, ... , Cn}, and the particular pairwise relations are determined for modeling with respect to a mathematical relation.

### *3.3 The application procedures of fuzzy DEMATEL*

To further explore the fuzzy DEMATEL research method in uncertainty, the analysis procedures are explained as follows:

Step 1: Identifying decision goal- gathering the relevant information to evaluate the advantages and disadvantages and monitoring the results to ensure the goals are achieved. This is necessary to form two expert committees for group knowledge to achieve the goals.

Step 2: Developing evaluation criteria and survey instrument- this is important to establish a set of criteria for evaluation. However, the criteria have the nature of complicated relationships within the cluster of criteria. To gain a structural model dividing evaluation criteria into the cause and effect groups, the fuzzy DEMATEL is appropriate to be applied in this study. Acquiring the responded instrument- to ensure the relationships among the evaluation criteria, it is necessary to consult two groups of experts to confirm reliable information of the criteria influences and directions

Step 3: Interpret the linguistic information into fuzzy linguistic scale- using linguistic information to convert fuzzy assessments applying in Eqs. (5)-(9) are defuzziffied and aggregated as a crisp value

Table 3. The prominence and relation axis for cause and effect group

| Criteria | D(Sum) | R(Sum) | (D+R) | (D-R) |
|---|---|---|---|---|
| C10 | 9.63 | 5.73 | 9.63 | 3.90 |
| C7 | 9.45 | 5.08 | 9.45 | 4.37 |
| C9 | 9.21 | 5.55 | 9.21 | 3.66 |
| C3 | 9.17 | 9.54 | 9.17 | (0.37) |
| C4 | 9.09 | 8.80 | 9.09 | 0.29 |
| C6 | 9.00 | 9.26 | 9.00 | (0.26) |
| C2 | 8.64 | 7.63 | 8.64 | 1.01 |
| C5 | 8.03 | 9.72 | 8.03 | (1.69) |
| C8 | 7.86 | 10.60 | 7.86 | (2.74) |
| C1 | 6.63 | 9.26 | 6.63 | (2.63) |

Step 4: Analyze the criteria into causal and effect diagram- the crisp value is composed of the initial direct relation matrix. The normalized direct relation matrix can be obtained direct relation matrix can be obtained through Eq. 10. Using Eqs. (11)- (15), a causal and effect diagram can be constructed.

## 4. Results

This study applies the fuzzy DEMATEL to GSCM performance in order to build up a cause and effect model for automobile manufacturing enterprises. This research conducts four proposed steps as follows:

Step 1: Determining decision objectives and assembling the relevant information for developing 15 GSCM performance criteria to study the interrelationships of criteria in uncertainty.

Step 2: This study sets up above 15 criteria for evaluation that are presented in Figure 1 through interview and extensive literature reviews.

Step 3: Clarifying the linguistic information into fuzzy linguistic scale as shown in Table 1. This study collected data to evaluate criteria which affect automobile manufacturing industry and applied the Eqs. (5) - (9) and convert the fuzzy numbers into crisp value.

Step 4: The crisp value of criteria from the fuzzy assessment is composed of the initial direct relation matrix. Once the normalized direct relation matrix is obtained and the total relation matrix is acquired by using formula. Then, the prominence axis (D+R) is created by adding D to R which involves in the importance of criterion and the relation axis (D-R) is created by subtracting D from R (Table 2). Hence, the causal and effect diagram can be obtained by mapping the data values of the (D+R, D-R) which will supply valuable insights for resolving problem those manufacturers are facing. The causal and effect diagram is shown in Figure 1.

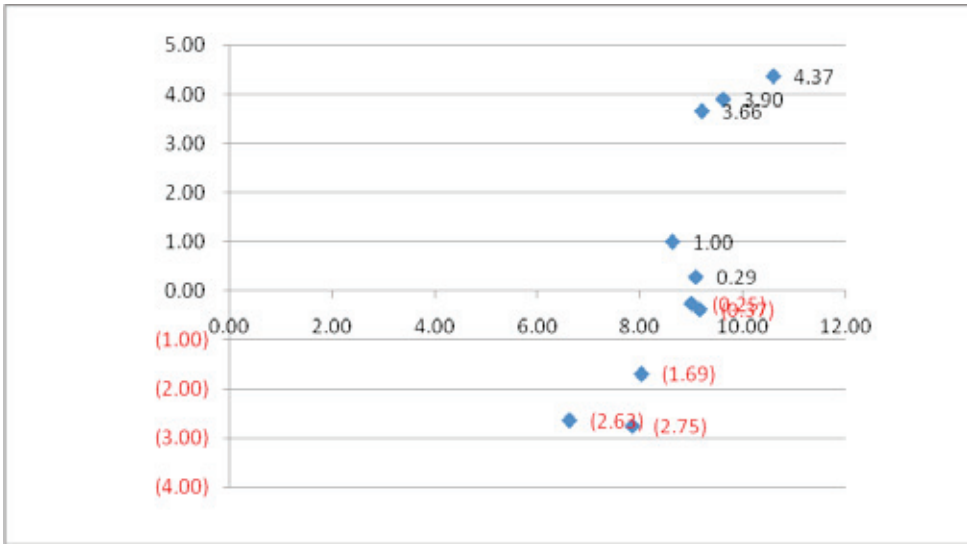


Figure 1. Cause and effects diagram

As shown in the causal diagram (Fig. 1), the evaluation criteria visually divided into the cause IT criteria group (C2, C4, C7, C9, and C10) can be invested, while the effect criteria group includes C1, C3, C5, C6, and C8. From the causal diagram, values cues are obtained for making profound decisions. These two cause and effect groups may be further used to respectively serve as causal criteria and effective criteria clusters in IT in SCM model.

The finding from the relationship between IT in CSM and firm performance via computing DEMATEL is presented. The degree to which the criteria play the role in entire firm performance will be discussion. The result provides a profound evident that IT is requirement for high firm performance. However, it cannot to say that these criteria of IT in SCM are the standard, since the criteria depend on the firm size, firm capabilities, and the existing organizational cultures.

The result proves that there is a positive and strong relationship between IT use and high firm performance. It was assumed that RFID, GPS and wireless technology (C9) provides enormous economic benefits to both business and consumers (Kelly and Erickson, 2005). Hence, GPS tags on products enable accurate counting and locating of the subjects in real-time, so customers can chase products which increasing customer trust. The information flow is more valuable to assess the inventory level and lead to reduce cost and time which is an important part of effective production. Thus, the C9 and Electronic Data Interchange (C10) are the most considered causes due to expert group strongly support that these criteria will help company get the marketing improvement via customer trust and lead to competitive advantage. Many researches showed that an integral element of managing partnerships throughout the length of the supply and demand chains is to aim streamline of process and

deliver higher value to final consumers by minimizing cost and time wastage (Chow et al, 2006). The empirical analysis also finds the equivalent results that supplier relationship management (C4) contributes a vital part on product development.

The result is in accordance with previous finding that ERP (C2) is still the domination software for managing a company's processes (Burka et al., 2005). This is since the system concerned is the key solution for produce information in real time for forecasting accurate market demand. However, in real situation, integrating ERP depend upon on many elements which are considering such as human resource, financial statement, and other systems. Some experts assert that control the relationship with partner will bring benefits, but other ideas support managing information flow in production is the more important factor. This can explain the ERP is considered more important than SRM.

In the real status financial firm performance (C7) is expected as the positive effects from IT investment. Nevertheless, it becomes the most important cause which can be explained by two aspects. First, there are complicated criteria in real situation, and the objective in each company is not completely the same. Second, high firm performance is not only depending on internal resources but also external cause like natural and social condition. Although many studies confirmed that IT impact on supply chain lead to better overall enterprise performance, at least, as measured by ROI, ROE, and market share. In this result, some considered important cause criteria become effect group (C1, C3, and C5). This is because IT is the initial required solution when successful performance is requested. To some extent, this study shows out how immediate IT impact variable may affect each other and contribute to an overall performance.

## 5. Managerial implications & Concluding remarks

The advanced technology will help textile manufacturing improve more efficient in their production processes. The Vietnam garment industry needs to increase investment to approach modern manufacturing facilities as well as improve production in order to maximize their inherent advantages to market proximity. The ERP software plays the role in information sharing across department. For instance, the sale team gives suggestion to the operation team on the new fashion trend to approach customers taste in the next season. MRP system identifies planning from beginning to end of garment products (spinning to weaving, dyeing, finishing and garments) which help to reduce time, production cost, and delivery to customer in timely.

SRM shares a high extent of involvement with supply chain partners helps the company outperform rivals by offering effective and efficient flows of services to customers. The RFID system allows to access more precise inventory information to manage raw material tightly which will prevent excess supplies and materials not needed due to garment firms have many kinds of raw material. The EDI provides a vital tool to adopt the technology collaboration between textile firm, raw material suppliers and retailer in developed the countries. The software will give the key to making the right decision for organizations because high production cost, slowly delivery, and slowly approach to customer changes are main causes for lose competitive advantages of garment the industry.

To successfully adapt the new technology, the managers must pay attention on what kind of technology systems need to be invested and how to aggregate these on their production status. The element which company must take into account when applying IT is human resource due to the technique skills of labor force is just in infancy level. The trades-off between IT cost and the productive utilization depending on firm size is also a concerned element. In addition, the software is not difficult to duplicate by competitors. However, it is not competitive advantage if the industry applies the old technology in compare with rivals in China or India.

This study proposes precious criteria for high firm performance which is the IT impact on SCM. These criteria determine material requirement, better respond to customer, faster react to market changes, improved utilization of facilities and labor, and reduced inventory level. The complicated relationships among all functional departments and these with customers are managed by the information system. The RFID, GPS, mobile, wireless technology, and Electronic data interchange are also evaluated as contributory criteria for organization. The measurements for firm improvement are evaluated by customer satisfaction which is to get closest various consumer demands, high financial statement including ROI, profitability, and cash flow and marketing performance via market share.

To find out the interrelationships among all criteria the DEMATEL method is applied. It is a mathematical computation to convert the relations between cause and effect of criteria into a visual structure model, and to handle the inner dependences within a set of criteria. The database for the method is expert ideas, because most of evaluators cannot give exact numerical value to represent opinions, the opinions are evaluated by linguistic assessments rather than numerical values (Wang and Chuu 2004). The empirical experimental result will shows out cause and effect criteria group which gives the guideline for decision-making for managers.

The result shows that cause criteria group includes C2, C4, C9, and C10. Effect criteria group comprises C6 and C8. It is no doubt that IT in SCM has result in high firm performances, but these relationships are affected by internal and external elements. It can explain some expected causes criteria become effect criteria. Therefore, manager should consider what and how to apply information system to get productivity. The result asserts that to some extent effective performances are determined by the flow of information in processes. Thus, the textile industry needs approach to “cloud technology”−computational resources is a severe requirement.

Some limitations and directions for future researches are presented here. This study conduct with small number of expert, so future research should observe more and the expert group who be interviewed from various fields not just in economics. ERP software has high cost and implementation risks. The future research should concern what kind of ERP suitable for textile firm. The list of technology in SCM is limited. Further, more information systems should be added. Developing a framework IT in SCM is affected by human resource or organizational culture. Future research should evaluate the IT investment and compare the performance in small, medium, and large firm size.

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